

THREE NEW ANDEAN SPECIES OF *AULONEMIA*
(POACEAE: BAMBUSOIDEAE: BAMBUSEAE) WITH SHEATH AURICLES

Emmet J. Judziewicz

Robert W. Freckmann Herbarium
Department of Biology and Museum of Natural History
University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
emmet.judziewicz@uwsp.edu

Eric J. Geisthardt

University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
Eric.J.Geisthardt@uwsp.edu

Lane D. Gibbons

University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
lgibb561@uwsp.edu

Dain C. Ziegler

University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
dzieg161@uwsp.edu

Michael J. Zueger

University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
Michael.J.Zueger@uwsp.edu

Sol Sepsenwol

Department of Biology
University of Wisconsin-Stevens Point
Stevens Point, Wisconsin 54481, U.S.A.
sol.sepsenwol@uwsp.edu

ABSTRACT

Four described species of the neotropical woody bamboo genus *Aulonemia* Goudot (Poaceae: Bambusoideae: Arthrostylidiinae) have prominent lunate, fimbriate, foliage leaf sheath auricles. We describe here three additional sheath-auriculate species from Andean South America. The new Bolivian species *Aulonemia insignis* has dimorphic culms: One type is vegetative and produces numerous, crowded, broad foliage leaves (with purple margins, unique in the genus), while the other type is fertile and produces only a few, small foliage leaves. Two other new Andean species, *Aulonemia fuentesii* (Bolivia) and *A. madidiensis* (Peru and Bolivia), differ from their sheath-auriculate congeners in their broad foliage leaves (4.7–9.3 cm wide) and awnless spikelets. *Aulonemia fuentesii* has foliage leaf blades 13–18 cm long and 4.7–5.7 cm wide, sheath fimbriae 8–15 mm long, and spikelets 23–40 mm long and 4–5 mm wide with 7–13 puberulent, 7–11-nerved fertile florets, while *A. madidiensis* has foliage leaf blades 22–33 cm long and 6.7–9.3 cm wide, sheath fimbriae 20–25 mm long, and narrower spikelets 1.9–2.5 mm wide with 5–7 glabrous, 5–9-nerved fertile florets. The epidermal foliage leaf blade micromorphology of each new species is characterized using scanning electron microscopy.

RESUMEN

Cuatro especies descritas de *Aulonemia* Goudot (Poaceae: Bambusoideae: Arthrostylidiinae), un género neotropical de bambú leñoso, poseen aurículas prominentes, semilunares y fimbriadas en las vainas de las hojas. Presentamos aquí tres especies nuevas, también con vainas auriculadas, encontradas en los Andes de América del Sur. La nueva especie Boliviana *Aulonemia insignis* tiene culmos dimórficos: Un tipo es vegetativo y produce numerosas hojas anchas (con márgenes de color púrpura, carácter único en el género), mientras que el otro tipo es fértil y produce pocas hojas pequeñas. Las otras dos nuevas especies andinas, *Aulonemia fuentesii* (Bolivia) y *A. madidiensis* (Perú y Bolivia), difieren de sus congéneres con aurículas por tener hojas anchas (4.7–9.3 cm de ancho) y espiguillas no aristadas. *Aulonemia fuentesii* tiene vainas foliares con fimbrias 8–15 mm de largo y láminas 13–18 cm de largo y 4.7–5.7 cm de ancho, y espiguillas 20–35 mm de largo y 4–5 mm de ancho, con 7–13 flósculos fértiles puberulentos con 7–11 nervios. *Aulonemia madidiensis* tiene vainas foliares con fimbrias 20–25 mm de largo y láminas 22–33 cm de largo y 6.7–9.3 cm de ancho, y espiguillas 20–35 mm de largo y 1.9–2.5 mm de ancho, con 5–7 flósculos glabros con 5–9-nervios. La epidermis foliar de las láminas de cada nueva especie es descrita con microscopía electrónica de barrido.

KEY WORDS: Poaceae, Bambusoideae, *Aulonemia*, Bolivia, Peru, Parque Nacional Madidi

INTRODUCTION

Aulonemia Goudot (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae) is a genus of about 45 named species (McClure 1973; Calderón & Soderstrom 1980; Clayton & Renvoize 1986; Judziewicz et al. 1999, 2000). The genus is characterized by culm nodes lacking promontories, each node with a single dominant branch;

typically abundant leaf fimbriae; and typically reflexed leaf blades. Recent collections (on loan from MO) from Parque Nacional Madidi on the northern slope of the Andes in western Bolivia (<http://www.mobot.org/MOBOT/Research/madidi/>) revealed several new species of *Aulonemia*, including three with sheath auricles described herein; one of them also occurs in adjacent Peru. None of these taxa is accounted for in recent treatments of Bolivian and Peruvian grasses, including bamboos (Tovar 1993; Renvoize 1998: 38–41; Judziewicz et al. 2010; Judziewicz & Clark 2011). The following key includes the four previously described species of *Aulonemia* with sheath auricles and the three novelties described in this paper.

1. Spikelets with fertile lemmas awned.
 2. Foliage leaf blades narrowly ovate to ovate, (1.9–)3.5–10 cm wide; Ecuador and Peru _____ *A. longiaristata* L.G. Clark & Londoño
 2. Foliage leaf blades linear-lanceolate, 0.7–1.7 cm wide; Venezuela _____ *A. purpurata* (McClure) McClure
1. Spikelets awnless.
 3. Foliage leaf blades 7–19 × 0.7–3.5 cm.
 4. Fimbriae erect; leaf blades 10–19 × (1.5–)2–4 cm; spikelets 12–30 mm long, the florets ca. 6 mm long; Bolivia _____ *A. boliviana* Renv.
 4. Fimbriae radially spreading; leaf blades 7–14 × 1.3–2.2(–3) cm; spikelets 20–37 mm long, the florets 6.5–8.5 mm long; Peru _____ *A. yanachagensis* Judz. & C.D. Tyrrell
 3. Foliage leaf blades 13–33 × 3.7–10 cm.
 5. Culms dimorphic; vegetative (or late-flowering?) culms with foliage leaf blades 13–17.5 × 4–4.7 cm and with purple margins apically and basally, the flowering culms with distant leaf blades 6–7 × 1–1.8 cm; fertile florets 6–7.3(–9) mm long, deep violet-purple; Bolivia _____ *A. insignis* Judz. & Gibbons
 5. Culms monomorphic, vegetative and flowering culms similar; foliage leaf blades 13–33 × 4.7–9.3 cm, uniformly green and not purple-margined; fertile florets (7–)8–10 mm long, tan to greenish suffused with purple; Bolivia and Peru.
 6. Foliage leaf blades 13–18 × 4.7–5.7 cm; fimbriae 8–15 mm long; spikelets 23–40 × 4–5 mm; fertile florets 7–13, puberulent, 7–11-nerved; Bolivia _____ *A. fuentesii* Judz. & Geisthardt
 6. Foliage leaf blades 22–33 × 6.7–9.3 cm; fimbriae 20–25 mm long; spikelets 20–35 × 1.9–2.5 mm, fertile florets 5–7, glabrous, 5–9-nerved; Bolivia and Peru _____ *A. madidiensis* Judz., D.C. Ziegler, & Zueger

Plants parts were measured using a mm ruler. A Hitachi S3400 scanning electron microscope in variable-pressure mode was used to examine the foliage leaf blade epidermises of all three species. Material was cut from well-developed blades without further drying or coating. For *Aulonemia insignis* and *A. fuentesii* just one leaf was examined from the type collections; for *A. madidiensis*, two collections were examined, one from Peru and one from Bolivia. Sections were cut from the marginal stripe of the blade, and as well as from the “non-striped” center of the blade.

Aulonemia insignis Judz. & Gibbons, sp. nov. (Figs. 1, 2a, 3, 4a–d). TYPE: BOLIVIA: DEPT. LA PAZ: PROV.: Bautista Saavedra, Área Natural de Manejo Integrado Apolobamba, sector Tajamarca, más allá de Chaka, por el antiguo camino Laji Sorapata – Apolo, 14°52'12"S, 68°46'28"W, 2906 m, bosque bajo de yungas en ceja de monte inferior pluvial de filos, plantas alcoholizadas, tejido en silicagel, bambú cerca a 1.7 m, botones; flores, espiguillas pardas, 12 Apr 2009, A.F. Fuentes & M. Villalobos 14008 (HOLOTYPE: MO; ISOTYPES: LPB not seen, UWSP).

Culmi usque ad 1.7 m longia, 1–3.5 mm diametro. Culmi dimorphi, solidi. Culmi sterili: Vaginae foliorum auriculatae 2–5 mm, fimbriae 20–35(–40) mm longae; laminae 13–17.5 × 4–4.7 cm. Culmi fertili: Vaginae foliorum auriculatae ca. 1 mm longae, fimbriae 2–3 mm longae; laminae 6–7 × 1.5–1.8 cm. Synflorescentia paniculata 20–25 × 20–25 cm. Spiculae 30–45 × 2–2.5 mm, glabrae, 5–7 flosculos continentes; gluma I 0.3–1.3 mm longa, gluma II 3–4.7 mm longa; lemmata fertilia 6–7.3(–9) mm longae, lanceolatae, acutae, violacea-purpurea.

Bamboo to 1.7 m tall, 1–3.5 mm in diameter, apparently cespitose, apically arching to pendulous. Culms dimorphic, apparently solid; branch one per node. Vegetative (or late flowering) culms with foliage leaves about 9 per complement, the rather crowded sheaths stramineous to more commonly strongly suffused with purple, distally sparingly to abundantly hispid with glassy hairs 3–5 mm long; sheath auricles present, lunate, 2.5–5 mm long, purple, densely beset with fimbriae, these 20–35(–40) mm long, abundant, golden, curling, erect to ascending; external ligule 0.2–0.3 mm long, extending only partially around sheath; inner ligules not evident; pseudopetioles 4–6 mm long, puberulent, purple, strongly reflexed; well-developed blades 13–17.5 cm long, 4–4.7 cm wide, broadly lanceolate, strongly reflexed, glabrous, acute and with narrow (1–2 mm wide) dark purple margins apically occasionally extending to one-half of the blade length, distally cuneate and asymmetrical with dark purple margins (1 mm wide), the central leaf margins green, a lighter marginal strip present abaxially. Flowering culms available not with typical foliage leaf complements; leaves with a distinct girdle ca.



FIG. 1. *Aulonemia insignis* (Fuentes & Villalobos 14008, MO, UWSP). A. Plant at Bolivian type locality (2906 m), 12 April 2009 (Alfredo Fuentes photograph). B. Detail of culm leaf showing hispid sheath, auricles, prominent fimbriae, and reflexed blade (Alfredo Fuentes photograph). C. Vegetative leaf complement showing numerous crowded, large leaf blades. D. Detail of vegetative leaf complement showing sheath auricles, fimbriae, and purple margins of leaf blade bases.



FIG. 2. A. Bolivian upper montane forest habitat (2906 m) of *Aulonemia insignis*, 12 April 2009 (Alfredo Fuentes photograph). B. Bolivian basimontane forest habitat (1700 m) of *Aulonemia fuentesii*, 29 June 2005 (Alfredo Fuentes photograph).

1 mm thick at the base, those in basal and midculm portions consisting of bladeless sheaths only, these 2.5–3.5 cm long, striate, hispid with glassy hairs 3–5 mm long, the summit truncate to concave, 1–2 mm wide; leaves in upper portions of culm with sheath auricles present, lunate, ca. 1 mm long, purple, with abundant delicate golden-brown marginal fimbriae 2–3 mm long; external ligule 0.2–0.3 mm long, extending only partially around sheath; inner ligules not evident; pseudopetioles 1.5–2 mm long, puberulent, purple, strongly reflexed; blades 2–3, distant, strongly reflexed, 6–7 cm long, 1.5–1.8 cm wide, color and shape similar to those of the vegetative culm; peduncle 7–10 cm long, glabrous. Synflorescence an open orbicular panicle 20–25 cm tall, 20–25 cm wide, the primary branches diverging from the rachis by 30–45°, the spikelet pedicels capillary, glabrous. Spikelets 30–45 mm long, 2–2.5 mm wide, slender, awnless, finely puberulent, 5–7-flowered, the florets loosely overlapping; glumes tan-brown, the lower glume 0.3–1.3 mm long, cufflike to linear and recurved, 1-nerved, the upper glume 3–4.7 mm long, lanceolate-ovate, acute, 5–7-nerved; lowermost sterile floret often present, tan-brown, the lemma 5–6 mm long, the palea as long as or slightly protruding from the lemma; fertile florets deep violet-purple, slightly stipitate, the stipes 0.3–0.5 mm long; lemmas 6–7.3(–9) mm long, narrowly ovate, acute, finely 7–9-nerved; paleas 6–7.5 mm long, often slightly longer than the lemmas, bicarinate. Flowers with lodicules 3, 1.3–1.7 mm long, sometimes protruding from the gaping floret at anthesis, hyaline, rhombic, with a distinct midnerve and 3–4 fine nerves in a fan-shaped arrangement, acute, their apices fringed with 7–10 erect, clear, readily deciduous cilia 2–3.5 mm long; stamens 3, the anthers 2.7–3.5 mm long, purple; pistil with stigmas 2, hispid. Fruit not seen.

Leaf micromorphology (*Fuentes & Villalobos 14008*, UWSP). Terminology follows Ellis (1979).

Adaxial (upper) surface (Fig. 4a):

Costal zones.—Rigid in appearance, corrugated and raised above intercostal zones, spaced 140–200 μm apart.

Papillae.—Common to scattered; globose, appearing warty; generally uniform in size, ca. 4 μm in diameter.

Stomates.—Not present.

Interstomatal cells.—Not present.

Long cells.—70–90 μm long, ca. 5 μm wide; outline markedly sinuous, interlocking, apparently flat; papillae arranged in single rows with 2–5 per row.

Bulliform cells.—One row evident in intercostal zone; elongate (length indeterminate).

Prickles.—None seen.

Short cells.—One seen; cross-shaped; ca. 15 μm long, ca. 12 μm wide; raised.

Microhairs.—Few; 2-celled, appearing equal in length; basal cell deflated, oblong, ca. 28 μm long, 13–16 μm wide; apical cell deflated, ca. 32 μm long.

Macrohairs.—None seen.

Abaxial (lower) surface (Fig. 4b–d):

Costal zones.—Spaced 140–200 μm apart.

Papillae.—Abundant; globose to slightly compound; large, generally uniform in size, ca. 6 μm in diameter.

Stomates.—Common; apparently low dome-shaped; stomates alternating; stomatal rows 3, adjacent to costal zones.

Interstomatal cells.—60–70 μm long, ca. 10 μm wide; outline indeterminate; papillae present, abundant, arrangement variable, apparently 1–2-rowed, 5–8 per row.

Long cells.—Dimensions difficult to discern due to dense papillae, ca. 65 μm long, ca. 20 μm wide; papillae arranged in single rows, 5–10 per row.

Prickles.—Abundant, ca. 5/10,000 μm^2 ; mostly in intercostal zones, present in costal zones; 65–85 μm long, 20–40 μm wide; base deflated.

Short Cells.—Apparently rectangular in shape; dimensions difficult to discern due to dense papillae, ca. 16 μm long, ca. 7 μm wide; apparently depressed into the costal zone.

Microhairs.—Few; bicellular; basal cell deflated, ca. 38 μm long, ca. 13 μm wide; apical cell deflated, 18–28 μm long.

Macrohairs.—None seen.

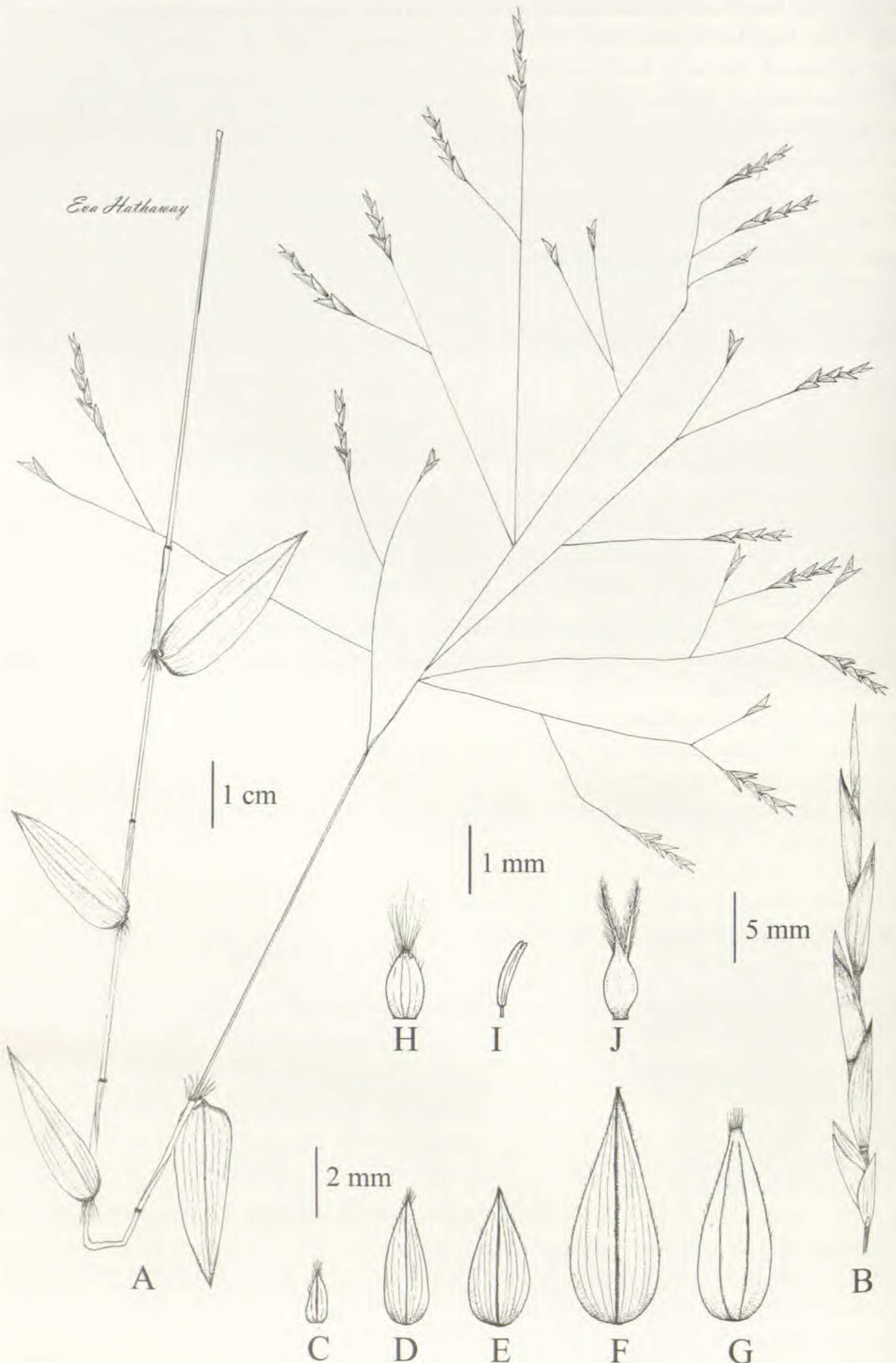


FIG. 3. *Aulonemia insignis* (Fuentes & Villalobos 14008, MO, UWSP). A. Flowering culm showing few, small foliage leaf blades. B. Spikelet. C. Lower glume. D. Upper glume. E. Lowest sterile lemma. F. Fertile lemma. G. Fertile palea. H. Lodicule. I. Stamen. J. Pistil. Illustration by Eva C. Hathaway.

Aulonemia insignis is distinctive in its bi-colored foliage leaves with both the base and apex of the blade having a distinctive wine-purple marginal stripe (Fig. 1c-d), hence the specific epithet "insignis," alluding to its resemblance to a military insignia.

Dimorphic culms, otherwise rarely developed in *Aulonemia*, are present in *A. insignis*. "Type 1" (Fig. 3) culms are elongate, arching, pendulous, and exhibit numerous bladeless sheaths on the middle and lower internodes, and a few distant leaves with small blades on the upper internodes. "Type 2" (Fig. 1c) culms are relatively short but have numerous large, crowded leaf blades. Based on the single collection and a careful examination of Fig. 1a, it appears that "Type 1" may represent an early-flowering culm, while "Type 2" may be just coming into flower. The Brazilian species *Aulonemia aristulata* (Döll) McClure sometimes produces extremely dimorphic culms, with tiny (a few cm tall) reduced leafless flowering culms produced from the base of "normal" leafy, flowering culms (Tarciso Filgueiras & Pedro Viana, pers. comm.).

Aulonemia boliviana Renv. may be closely related to *A. insignis*. The former species differs in its monomorphic culms, narrower leaf blades (1.5–)2–4 cm wide that lack marginal purple stripes, and shorter spikelets only 12–30 mm long. *Aulonemia viscosa* (Hitchc.) McClure from Costa Rica (Pohl 1980; Pohl & Davidse 1994) has distinctly purple-suffused blade bases, but is otherwise quite different morphologically from *A. insignis*.

Alfredo Fuentes (pers. comm.) notes the habitat of the new species as "open areas of a very wet upper montane forest (or upper montane cloud forest) in [areas] frequently exposed to winds and clouds" (Fig. 2a). He notes associates as *Weinmannia microphylla* Kunth (Cunoniaceae), *Bomarea cornuta* Herb. (Alstroemeriaceae), *Ternstroemia* sp. (Pentaphragmaceae), *Clusia* sp. (Clusiaceae) and *Miconia* sp. (Melastomataceae). A species of the bamboo genus *Chusquea* Kunth is also visible in the background of one of his photos of *Aulonemia insignis* (Fig. 1a).

***Aulonemia fuentesii* Judz. & Geisthardt, sp. nov. (Figs. 2b, 4e–f, 5).** TYPE: BOLIVIA. LA PAZ: Franz Tamayo, Parque Nacional Madidi, entre Carjata y Río Yana Lomas, 14°34'12"S, 68°54'00"W, 1700 m, bosque con *Juglans boliviana*, sabanas y matorrales subandino superior estacionales, pasto macollero colonial hasta 2.5 m, frutos maduros y viejos, abundante en chaparrales quemados, 29 Jun 2005, A. Fuentes, E. Cuevas & R. Cuevas 9112 (HOLOTYPE: MO; ISOTYPES: LPB not seen, UWSP).

Culmi usque ad 2.5 m longia, 0.7 cm diametro. Vaginae foliorum auriculatae, fimbriae 8–15 mm longae; laminae foliorum 13–18 cm longae, 4.7–5.7 cm late. Synflorescentia paniculata 45 cm longae, 30 cm latae. Spiculae 23–40 mm longae, 4–5 mm latae, puberulentes, 7–13 flosculos continens; gluma I 2–3.5 mm longa, glume II 3.5–5 mm longa; lemmata fertilia 8–10 mm longa, lanceolatae, acutae.

Cespitose colonial bamboo; culms up to 2.5 m tall, at least 0.7 cm in diameter in available material, the culms weak and hollow. Internodes striate, stramineous, obscurely green-maculate, glabrous or with a few appressed 1 mm long cilia below. Leaves with sheaths striate, stramineous, obscurely green-maculate, glabrous or with a few appressed 1 mm long cilia below, the margins efimbriate, the apex with a prominent lunate purple brown 4–8 mm long fimbriate auricle on one side, the fimbriae 8–15 mm long, delicate, curling, golden-brown, more-or-less radiate, the outer ligule 1 mm long, on the side opposite the auricle prolonged into an ovate, loosely confluent group of fimbriae ca. 5 mm long; inner ligule not evident; pseudopetiole 2–3 mm long; blades 13–18 cm long, 4.7–5.7 cm wide, ovate, somewhat reflexed, obtuse to nearly truncate at the slightly asymmetrical base, acuminate at the apex, glabrous, the margins cartilaginous, antrorsely scabrous. Peduncle ca. 20 cm long, stout, glabrous, striate, and shining. Synflorescence an ovoid panicle up to at least 45 cm tall and 30 cm wide, the primary branches whorled and ascending at about a 45° angle, the secondary and tertiary branches lax, the spikelet pedicels up to 4 cm long, smooth and capillary. Spikelets 23–40 mm long, 4–5 mm wide, stramineous, the bracts acute and awnless; glumes glabrous, the lower glume 2–3.5 mm long, lanceolate, 1–3-nerved; upper glume 3.5–5 mm long, narrowly lanceolate, 3–5-nerved; lowermost floret sterile, lacking a palea, the lemma 6–7 mm long, 5–9-nerved; fertile florets 7–13, the lemmas 8–9 mm long, broadly lanceolate, acute, glabrous in the upper half, finely appressed-puberulent in the lower half, finely 7–11-nerved, the midnerve and main lateral nerves sometimes slightly excurrent as submucros, the lemma thus appearing tridentate; paleas 8–9.5 mm long, usually slightly protruding from the lemmas, bicarinate, the keels ciliolate. Flowers with lodicules 3, 1.3–1.5 mm long, rhomboid, acute, 2-nerved, transparent, fringed with erect, clear, readily deciduous cilia

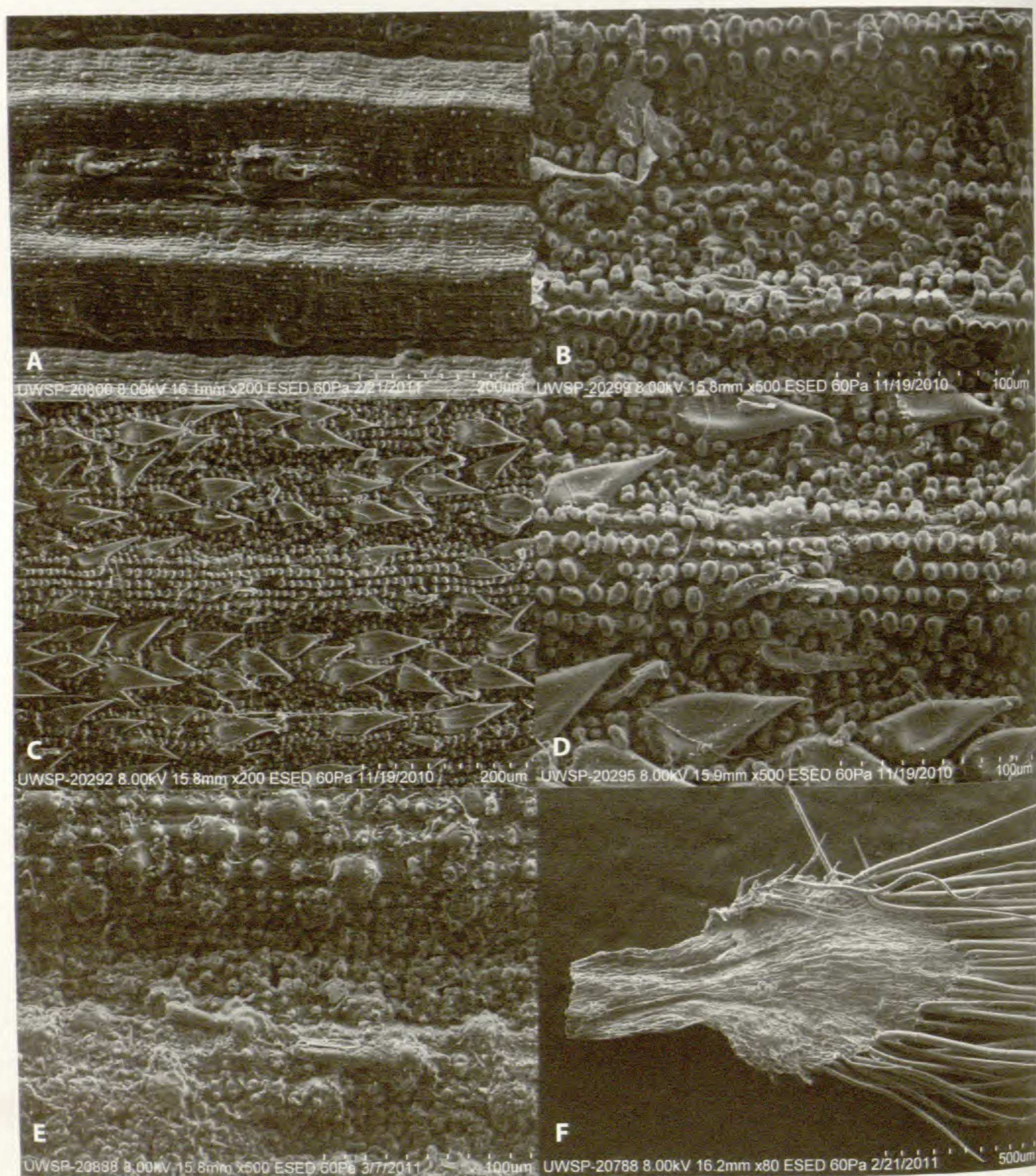


FIG. 4. Scanning electron micrographs (SEMs). A. Adaxial (upper) leaf blade epidermis of *Aulonemia insignis* (Fuentes & Villalobos 14008, UWSP). B–D. Abaxial (lower) leaf blade epidermis of *Aulonemia insignis* (Fuentes & Villalobos 14008, UWSP); B from central part of blade, showing absence of prickles. C–D from marginal stripe, showing abundant deflated prickles. E. Abaxial (lower) leaf blade epidermis of *Aulonemia fuentesii* (Fuentes et al. 9112, UWSP). F. Lodicule of *Aulonemia fuentesii*, showing abundant, elongate, readily deciduous cilia (Fuentes et al. 9112, UWSP).

1.5–2.5 mm long (Fig. 4f); stamens not seen; pistil not seen. Fruit immature, a brown linear caryopsis 3–4 mm long with a long linear hilum.

Leaf micromorphology (Fuentes et al. 9112, UWSP); the material available was in weathered, overmature condition and many character states were not easily determinable. Terminology follows Ellis (1979).

Adaxial (lower) surface: Surface glabrous, sparsely papillate, with scattered conical prickles 30–38 μm tall.

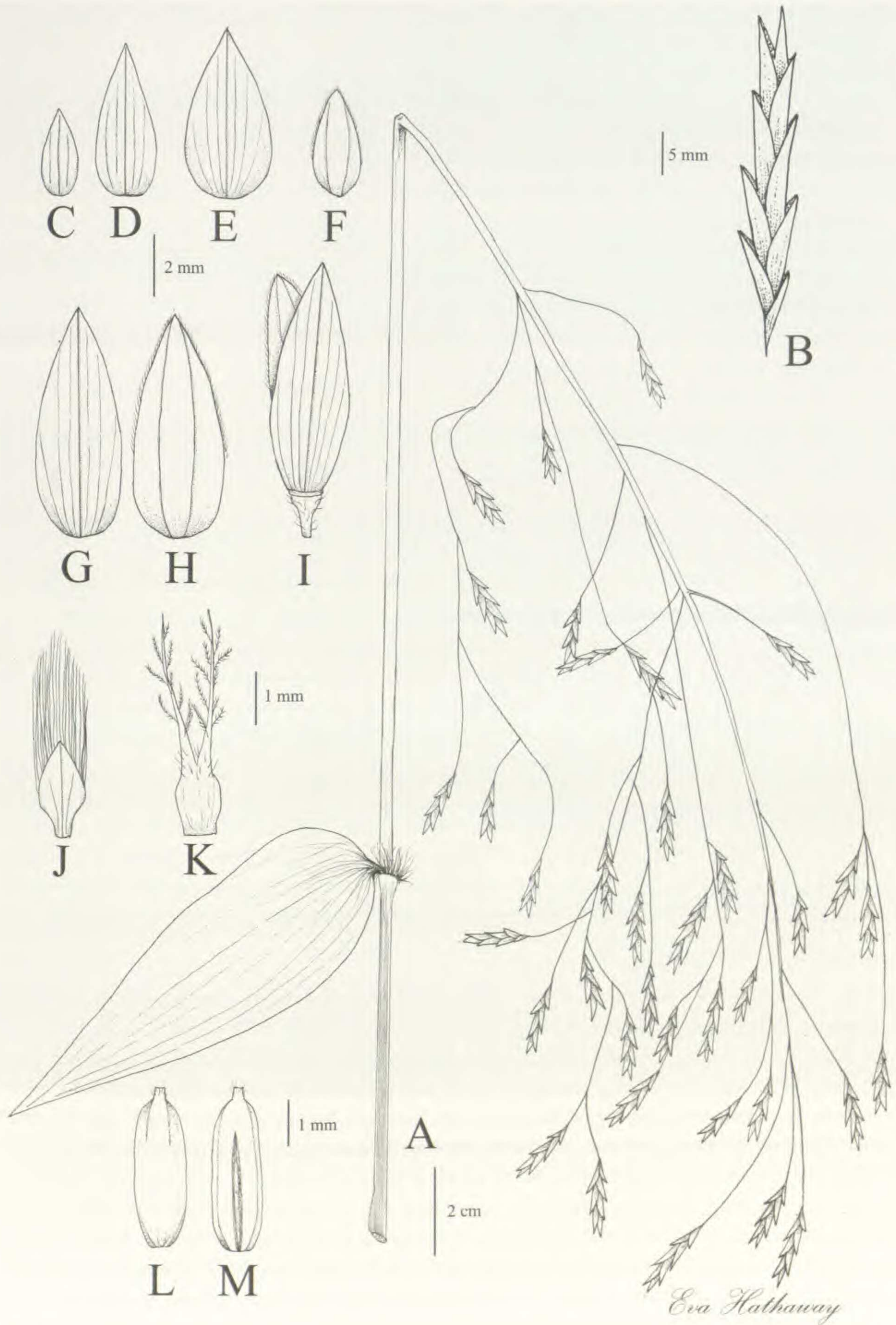


FIG. 5. *Aulonemia fuentesii* (Fuentes et al. 9112, UWSP). A. Flowering culm. B. Spikelet. C. Lower glume. D. Upper glume. E. Lowest sterile lemma. F. Lowest sterile palea. G. Fertile lemma. H. Fertile palea. I. Fertile floret. J. Lodicule. K. Pistil. L. Caryopsis, dorsal view. M. Caryopsis, ventral view. Illustration by Eva C. Hathaway and Eric J. Geisthardt.

Abaxial (lower) surface (Fig. 4e):

Costal zones.—Spaced 200–240 μm apart.

Papillae.—In general abundant, globose; simple.

Stomates.—Difficult to discern, apparently throughout intercostal zone; apparently deeply sunken and over-arched by papillae.

Interstomatal cells.—Not readily discernable, obscured by overarching papillae.

Long cells.—Difficult to discern, apparently throughout intercostal zone; apparently deeply sunken and over-arched by papillae.

Prickles.—None seen.

Short cells.—Common, 20–24 μm in diameter, slightly raised, sparse in intercostal zones, 2–3 rows (25–30 μm) in costal zones.

Microhairs.—Occasional, not well-preserved; bicellular; basal cell 30–33 μm long, ca. 7 μm wide, not deflating; apical cell 35–40 μm long, ca. 5 μm wide, deflated.

Macrohairs.—Occasional, 45–55 μm long, slender.

Aulonemia fuentesii is known only from the type specimen, and is named in honor of Alfredo F. Fuentes Claros (b. 1971), Investigador Asociado at the Herbario Nacional de Bolivia, ecologist, bryologist, conservationist, and prolific collector of the flora of Parque Nacional Madidi. The new species differs from *Aulonemia madidiensis* by the characters given in the key above; briefly, it is a vegetatively less robust species with more robust, floriferous spikelets.

Fuentes (pers. comm.) describes the habitat of *Aulonemia fuentesii* as basimontane seasonal forest (Fig. 2b) and savanna, interspersed with anthropogenic, frequently burnt chaparrals in which his eponym is locally dominant. He also noted the following associates at the type locality: *Juglans boliviana* (C. DC.) Dode (Juglandaceae; dominant in primary forests), *Ceroxylon weberbaueri* Burret (Arecaeae), *Barnadesia woodii* D.J.N. Hind (Asteraceae), *Miconia tiliifolia* Naudin (Melastomataceae), *Justicia kuntzei* Lindau (Acanthaceae), *Mucuna rostrata* Benth. (Fabaceae), and *Spirotheca rosea* (Seem.) P.E. Gibbs & W.S. Alverson (Malvaceae).

Aulonemia madidiensis Judz., D.C. Ziegler, & Zueger, sp. nov. (Figs. 6–7). TYPE: BOLIVIA. LA PAZ: Franz Tamayo, Parque Nacional Madidi, N de Apolo, bosque andino semideciduo del sector Yarimita, 14°32'48"S, 68°41'37"W, 930–940 m, 2 m, espigas frutales cafes a moradas, 8 Mar 2005, Araujo-Murakami, Jorgensen & Cuevas 1741 (HOLOTYPE: MO; ISOTYPES: LPB not seen, UWSP).

Culmi usque ad 2 m longa, 0.5–1 cm diametro. Vaginae foliorum auriculatae, fimbriae 20–25 mm longae; laminae foliorum 22–33 cm longae, 6.7–9.3 cm late. Synflorescentia paniculata usque ad 55 cm longae, 40 cm latae. Spiculae (20–)25–35 mm longae, 1.9–2.5 mm latae, glabrae, 5–7 flosculos fertiles continens; gluma I 1–3(–5) mm longa, glume II (2–)3–5(–6) mm longa; lemmata fertilia (7–)8.5–10 mm longa, lanceolatae, acutae.

Habit unknown; culms reportedly 2 m tall, in available material 5–10 mm in diameter, weak, thin-walled, hollow, stramineous and faintly green-maculate, smooth, striate, glabrous, the lumen occupying about 70% of the diameter of the culm; nodes brownish. Culm leaves not seen in available material. Foliage leaves glabrous, the sheaths striate, stramineous, faintly green-maculate, slightly glaucous, lacking marginal fimbriae, with a pair of prominent deciduous purplish-brown lunate auricles (one auricle conspicuously larger than the opposite auricle) 7–12 mm long bearing conspicuous radiate, curling, delicate, golden-brown fimbriae 20–25 mm long; outer ligules ca. 1 mm long, fringed with delicate fimbriae up to 3 mm long; inner ligules not evident; pseudopetioles 3–4 mm long, thickened; blades 22–33 cm long, 6.7–9.3 cm wide, broadly lanceolate, somewhat coriaceous, ascending on available material, obtuse to cuneate at base, acuminate at apex, glabrous, the margins cartilaginous, smooth and somewhat tessellate below and scaberulous above. Peduncle up to at least 15 cm long, stout and glabrous. Synflorescence an ovoid panicle up to at least 55 cm tall and 40 cm wide, the rachis and primary branches angled, glabrous, stramineous with faint green maculations, sparingly glaucous, the primary branches spreading and abundantly rebranched; spikelet pedicels up to 4 cm long, capillary, antrorse-ly scabrous. Spikelets (20–)25–35 mm long, 1.9–2.5 mm wide, slender, glabrous, the bracts all lanceolate, acute, and awnless, slightly bicolored (stramineous suffused with purplish near their apices); lower glume 1–3(–5)

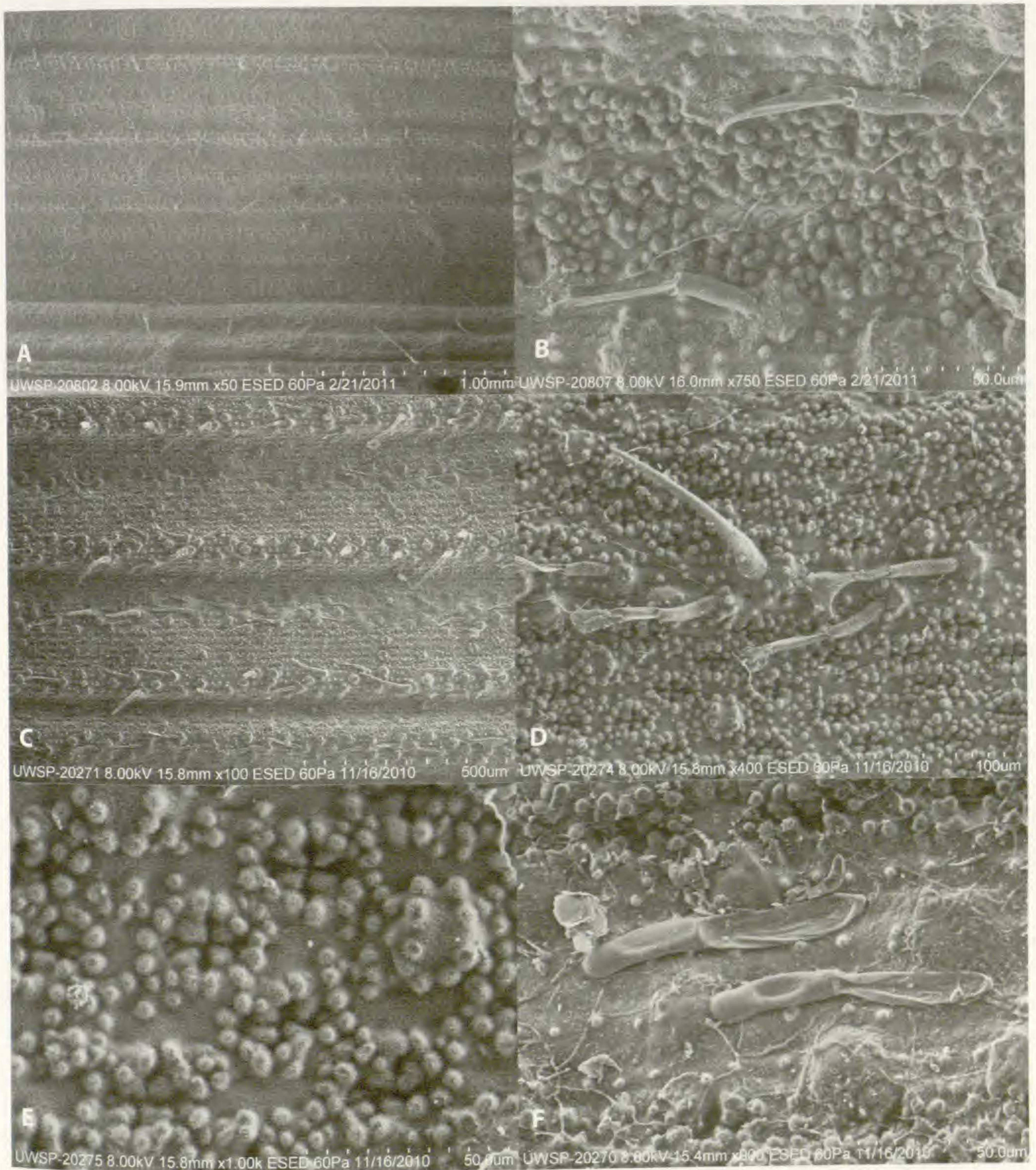


FIG. 6. Scanning electron micrographs (SEMs) of abaxial (lower) leaf blade epidermis of *Aulonemia madidiensis*. A-B based upon Araujo-Murakami et al. 1741 (UWSP), from Bolivia; C-F based upon Vargas 17282 (US), from Peru. Aspects highlighted: B and F, bicellular microhairs; D, cilia; E, stomates over-arched on four corners by papillae.

mm long, 1-3(-5)-nerved; upper glume (2-)3-5(-6) mm long, 3-7-nerved; sterile florets 3(4); lowest sterile floret lacking a palea, the lemma 3-8 mm long, 5-7-nerved; fertile florets 5-7, the lemmas (7-)8.5-10 mm long, 5-9-nerved; fertile paleas 2.3-4.5 mm long, bicarinate; uppermost floret reduced and sterile. Flowers with lodicules 3, 0.5-2 mm long, rhombic, 2-3-nerved to the apex, tipped with abundant erect, clear, readily deciduous cilia 1.1-1.9 mm long; stamens 3, the anthers 0.5-2 mm long; pistil with 2 hispid stigmas. Fruit not seen.

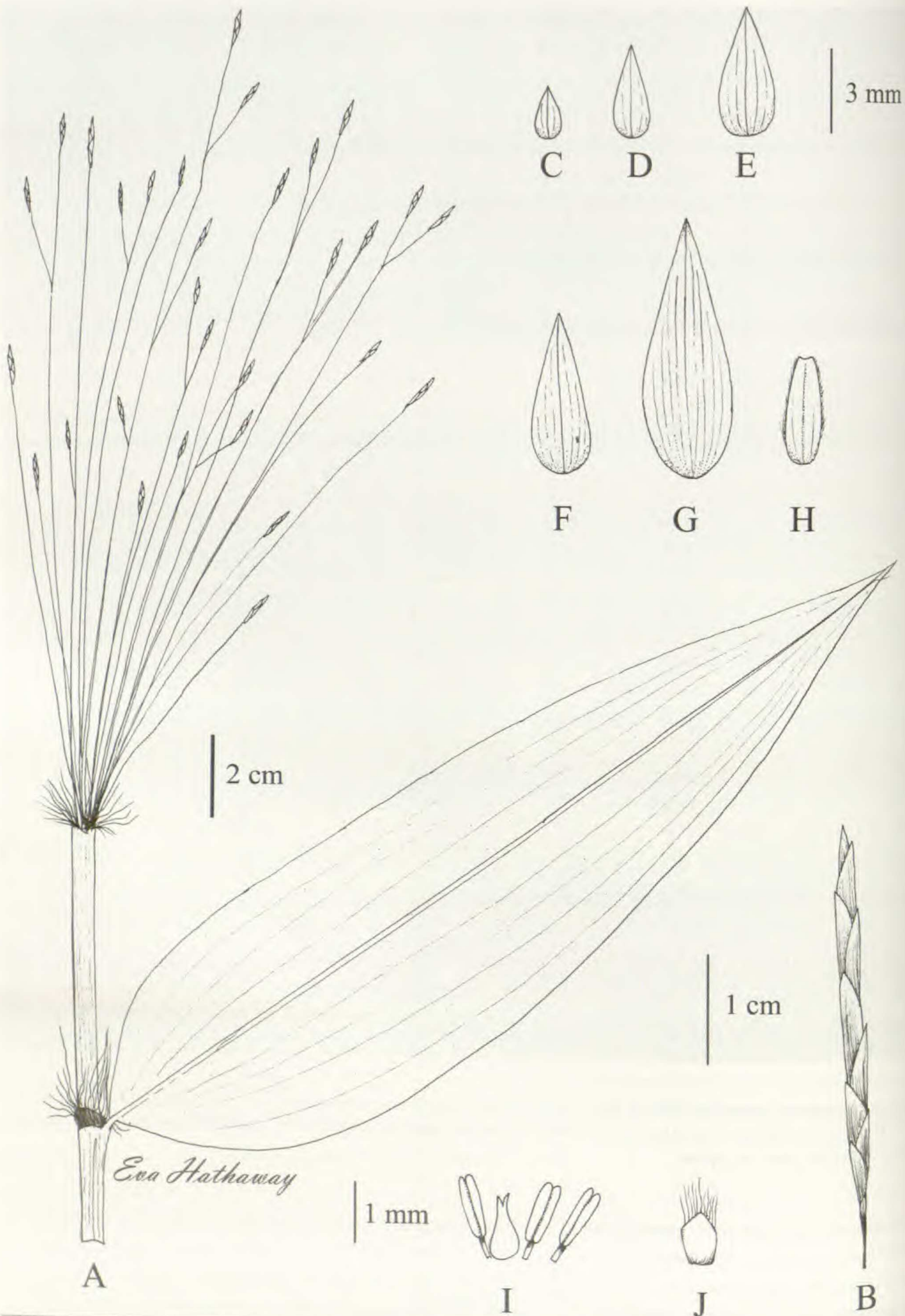


FIG. 7. *Aulonemia madidiensis* (Paniagua et al. 5895, Bolivia, UWSP). A. Flowering culm. B. Spikelet. C. Lower glume. D. Upper glume. E. Lowest sterile lemma. F. Second lowest sterile lemma. G. Lowermost fertile lemma. H. Fertile palea. I. Stamens and pistil. J. Lodicule. Illustration by Eva C. Hathaway.

Leaf micromorphology. Terminology follows Ellis (1979).

Abaxial (lower) surface of Bolivian specimen (Fig. 6a–b; Araujo-Murakami et al. 1741, UWSP):

Costal zones.—Spaced 140–190 μm apart.

Papillae.—In general very abundant, globose; simple; variable; waxy coat.

Stomates.—Common; shape triangular to dome-shaped, partly obscured by overarching papillae; each stomate overarched by 4 irregularly compound papillae, each papillae 4–7 μm long; stomatal rows 4–6, distinct, flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—33–37 μm long, narrow, width variable; ends indeterminable due to overarching papillae; papillae absent.

Long cells.—Rectangular, 94–110 μm long, 14–21 μm wide, outline of cells sinuous; papillae common, in one or two rows, 5–6 per row/cell, 4–7 μm long, globose.

Prickles.—None seen.

Short cells.—Abundant, 26–28 μm tall, 16–22 μm wide, abundant, slightly raised, in ca. 5 rows (60–70/mm) in intercostal zones, ca. 3 rows (30–45/mm) in costal zones.

Microhairs.—Common; bicellular; basal cell 28–47 μm long, 7–9 μm wide; apical cell ca. 44 μm long.

Macrohairs.—Few; distinctly conical, 118–142 μm long.

Leaf anatomy – abaxial (lower) surface of Peruvian specimen (Fig. 6c–f; Vargas 17282, US):

Costal zones.—Spaced ca. 280 μm apart.

Papillae.—Common to abundant, globose to slightly oblique.

Stomates.—Common; shape triangular to dome-shaped, partly obscured by overarching papillae; cross-shaped stomates; each stomate overarched by 4 irregularly compound papillae, each papillae 3–6 μm long with 10–13 papillae surrounding each stomate; stomatal rows 4–6, distinct, flanking each costal zone and slightly extending into the intercostal zone.

Interstomatal cells.—19–24 μm long, narrow, width approximately 9 μm ; ends indeterminable due to overarching papillae; papillae sparse, 3–5 per cell.

Long cells.—Rectangular, 47–85 μm long, up to ca. 14 μm wide, outline of cells sinuous; papillae sparse, 3–12 per cell, 3–5 μm long, apparently minutely concave at summit.

Prickles.—None seen.

Short cells.—Abundant, 14–24 μm tall, nearly round, in costal zones, not evident in intercostal zone.

Microhairs.—Common; bicellular; basal cell ca. 41 μm long, ca. 9 μm wide; apical cell 53–59 μm long and 6–8 μm wide.

Macrohairs.—Common; 118–142 μm long, 9–14 μm wide.

Additional specimens examined: **BOLIVIA. La Paz:** Franz Tamayo, Parque Nacional Madidi, sobre la senda que va de Virgen del Rosario hacia Mojos, a dos horas bajando por la orilla izquierda del Río Tuichi, 14°34'50"S, 68°41'27"W, 975 m, graminoide de 3 m de alto, inflorescencias nuevas verde parduscas, 7 Nov 2003, N. Paniagua, L. Cayola, L. Cuevas, C. Cuevas 5895 (MO-2); Franz Tamayo, Senda Virgen de Rosario-Mojos, entre el Arroyo Wichu Wichu y Sumpulo, siguiendo por una senda que se separa de las senda principal, 14°35'24"S, 68°46'03"W, 1280 m; bosque montano semideciduo, de 10 m de alto, en el filo de la loma, sotobosque denso; bambú de 1 m, individuos juveniles, erectos, formando matas compactas; culmo redondo, hueco, liso, verde con manchas moradas más intensamente en la base de los internodos; hojas del culmo caducas; hoja de las ramas verde claro en el envés, frescas después del corte, Jiménez 5266 (MO). **PERU. Cusco:** Prov. La Convención, Palma Real, Alto Urubamba, 900–1000 m, borde monte, 16 Apr 1966, Vargas 17282 (US-2).

Etymology.—Named after Parque Nacional Madidi in Bolivia, this robust species has prominent large, dark, “wrap-around,” lunate sheath auricles, large foliage leaf blades, and large, effuse panicles of slender, awnless, somewhat short bi-colored spikelets. *Aulonemia madidiensis* differs from *A. fuentesii* in the characters given in the key, and from the Ecuadorian endemic *A. longiaristata* in its awnless spikelets. It is unusual in the genus for its low elevation range (900–1280 m) and its subandean semi-deciduous forest habitat. Associates noted by the collectors at the type locality included *Acacia lorentensis* J.F. Macbr. (Fabaceae), *Adenantha colubrina* (Vell.) Brenan (Fabaceae), *Casearia gossypiosperma* Briq. (Salicaceae), *Gallesia intregrifolia* (Spreng.) Harms (Phytolaccaceae), and *Phyllostylon rhamnoides* (J. Poiss.) Taub. (Ulmaceae).

Another Peruvian collection from Depto. Cusco could possibly be this species: Urubamba: Dist. Machu Picchu, Pampacahua, bosque humedo, 13°06'S, 72°16'W, 2485 m, hierba 4 m, flores lilas, inflorescencias en panoja, 22 Jan. 2005, L. Valenzuela, E. Succhi, J. Farfán, V. Chama & N. Anaya 4635 (MO). However, its foliage leaf blades are relatively shorter and more ovate (approximately 23 × 7 cm) than that of the type specimen, its (very immature) spikelets are only 9–12 mm long, and it is found at a much higher elevation (2485 m). A fragmentary, high elevation (3100 m) collection from Depto. Cusco: Prov. La Convención, San Luis, 16 Jan. 1968, bosque húmedo subtropical, 1–2 m tall, flowering, Chávez Alfaro 38 (US-2), may pertain to this species, but has smaller foliage leaf blades 22 cm long and 4 cm wide, and spikelets only 12–14 mm long. Perhaps the elevation given on the label is in error; it seems unlikely that a humid subtropical forest grows at such a high elevation.

ACKNOWLEDGMENTS

We thank UWSP student Eva C. Hathaway for the line drawings, Alfredo Fuentes for the field photographs and notes, Gerrit Davidse and James Solomon for the loan of specimens from MO, Lynn G. Clark and Jimmy Triplett for helpful reviews, Christine M. Waas for research assistance and Virginia Freire for checking the Spanish.

REFERENCES

- CALDERÓN, C.E. AND T.R. SODERSTROM. 1980. The genera of Bambusoideae (Poaceae) of the American continent: keys and comments. *Smithsonian Contr. Bot.* 44:1–27.
- CLAYTON, D.K. AND S.A. RENVOIZE. 1986. *Genera graminum: Grasses of the world*. Her Majesty's Stationery Office, London.
- ELLIS, R.P. 1979. A procedure for standardizing comparative leaf anatomy in the Poaceae. II. The epidermis as seen in surface view. *Bothalia* 12:641–671.
- JUDZIEWICZ, E.J. AND L.G. CLARK. 2011. *Aulonemia cochabambensis* (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae), an anomalous new species from Bolivia. *Brittonia* 63:375–378.
- JUDZIEWICZ, E.J., L.G. CLARK, X. LONDOÑO, X., AND M.J. STERN. 1999. *American bamboos*. Smithsonian Institution Press, Washington, DC. 392 pp.
- JUDZIEWICZ, E.J., E.L. SHEA, AND T.M. WAYDA. 2010. Two new Bolivian species of *Aulonemia* (Poaceae: Bambusoideae: Bambuseae). *J. Bot. Res. Inst. Texas* 4:569–579.
- JUDZIEWICZ, E.J., R.J. SORENG, G. DAVIDSE, P. PETERSON, T.S. FILGUEIRAS, AND F.O. ZULOAGA. 2000. Catalogue of New World grasses (Poaceae): I. Subfamilies Anomochlooideae, Bambusoideae, Ehrhartoideae, and Pharoideae. *Contr. U.S. Natl. Herb.* 39:1–128.
- MCCLURE, F.A. 1973. Genera of bamboos native to the New World. *Smithsonian Contr. Bot.* 9:1–148.
- POHL, R.W. 1980. Family #15, Gramineae. In *Flora Costaricensis*, Fieldiana Botany, New Ser. 4.
- POHL, R.W. AND G. DAVIDSE. 1994. *Aulonemia*. In: Davidse, G., M. Sousa, and A.O. Chater, eds. *Flora Mesoamerica*. Vol. 6, Alismataceae a Cyperaceae. Universidad Autónoma de México, Mexico, D.F. Pp. 198–199.
- RENVOIZE, S.A. 1998. *Gramíneas de Bolivia*. Kew: Royal Botanic Gardens.
- TOVAR, O. 1993. Las gramíneas (Poaceae) del Perú. *Ruizia* 13:1–480.